

2 Economic and Social Effects of Water Quality Limits of Produced Water

2.1 Introduction

The Wyoming Department of Environmental Quality (WDEQ) is reviewing a petition to change the current effluent limits for total dissolved solids (TDS) and sulfate, and to add an effluent limit for barium, for coal bed natural gas (CBNG) industry produced water. The petitioners argue that the current effluent limits are not “protective of stock and wildlife.” However, the State, before recommending water quality standards (including effluent limits) for Wyoming, must consider a range of criteria (W.S. 35-11-302(vi)), including:

- (A) the character and degree of injury to or interference with the health and well-being of people, animals, wildlife, aquatic life and plant life affected;
- (B) the social and economic value of the source of pollution;
- (C) the priority of location in the area involved;
- (D) the technical practicability and economic reasonableness of reducing or eliminating the source of pollution; and
- (E) the effect upon the environment.

In direct response to the petition, the ecological risk assessment (ERA, Chapter 1 of this report) evaluated W.S. 35-11-302(vi)(A), the character and degree of injury to the health and well-being of livestock and wildlife affected by effluent limits. However, other factors that bear upon the reasonableness of effluent limits should not be overlooked. Principally, the character and degree of injury to the well-being of the people, and the social and economic value of produced water discharge should be carefully weighed, because the decision to change current effluent limits would affect not only water *quality*, but ultimately water *quantity*. This is because unnecessarily stringent effluent limits for produced water discharges will result in reduced water discharge to surface water bodies, since the economics of treating large quantities of produced water are such that injection/reinjection, deep disposal, and/or reduced exploration and development are likely results of additional

treatment requirements. For examples, see Table 1-1 for a comparison of current discharge water quality data to the petition proposed limits.

Social and economic value to residents in Wyoming, and possible injury caused by reductions in exploration/development and produced water discharge are described in subsequent sections of this report. Although the petition targets only CBNG production in Wyoming, conventional oil production operations could also be affected by state-wide changes in effluent limits, and hence the effects on these industries are also considered.

Counties principally affected by produced water discharges include Bighorn, Hot Springs, Washakie and Park counties in the Bighorn basin; Freemont and Natrona counties in the Platte River basin; and Converse, Campbell, Johnson, Natrona and Sheridan counties in the Powder River basin. Hence, for purposes of this report, economic and social considerations are focused on these areas only.

2.2 W.S. 35-11-302(vi)(B) - The Social and Economic Value of the Source of Pollution

Since the advent of conventional and CBNG produced water discharge in Wyoming, numerous livestock owners, farmers and wildlife populations have used the increase in water supply to their advantage. Letters of beneficial use, written by landowners and received by industry, BLM and state agencies, describe a heavy dependence on produced water discharge to support their livelihood in ranching and farming (Appendix B). Examples include:

- Produced water in Five Mile Creek supports over 2,500 head of livestock for two operators (B. Garland 2002, L. Mantle 2002).
- R. Pattison (2002) is able to generate income by renting irrigated pastureland to cattle and sheep ranchers. The productivity of the irrigated pastureland is the result of using produced water discharges.
- J. Wilson and T. Wilson (2006) rely on produced water sources from the Gebo and Little Sand Draw oil fields to maintain their cattle herds on 19,000 acres of BLM lands.
- R. Larson (2002) uses produced water discharges for livestock and irrigation operations in his 3,000-acre pasture.
- A. Baird (1988) was able to increase his crop production by 300% between 1968 and 1988 with the use of produced water. Similarly, P. Ward (2006) cites a 300% increase in alfalfa hay production attributable to produced water sources.
- Produced water from Hamilton Dome oil field has been used to irrigate about 500 acres of ranchland along Cottonwood Creek, which otherwise could not be irrigated (J. Baird 1988).

In addition to individuals' letters, use attainability analyses for Salt Creek and Cottonwood Creeks (RETEC 2004, SWWRC et al. 2002) surveyed agricultural uses of these areas, and found that most of the available land that receives produced water discharges is now used almost year-round for livestock grazing of cattle and sheep. Ranches in the Salt Creek area consist of both privately owned land and leased land. Almost all of the ranches have access to Salt Creek or related tributaries that receive discharged produced water. Ranching on the lands adjacent to Salt Creek produced over 4,500 head of cattle and 3,300 head of sheep in 2002. Distributed between eight operations, this inventory accounts for 0.3% of all cattle and

0.7% of all sheep raised in Wyoming in 2002 (NASS 2002). About 35 landowners have property adjacent to Cottonwood Creek; nearly all of them benefit from produced water discharges through irrigation and/or stock watering. An estimated two-thirds of all crop production in the Cottonwood Creek area was attributable to produced water discharges. A good portion of the crops includes grass hay and alfalfa, which are used to feed cattle in winter months, hence further benefiting ranchers.

Produced water discharges also support populations of wildlife species that may not otherwise be viable. Improved water quality of the streams from produced water discharges in the Powder River basin, and the perennial streams created in the Bighorn basin from produced water discharges, attract many wildlife species and supports greater populations, including big game, small game birds, and wild horses. The increase in game populations also generates greater revenue from hunting, fishing, and related tourism in the Cottonwood Creek area (SWWRC et al. 2002). The drainages create additional foraging areas for a variety of large and small mammals and, subsequently, important prey resources for raptors. The creeks are used as stopover resting and foraging areas for a variety of migratory birds and waterfowl species, and habitat for threatened and endangered species. Finally, discharges may also support critical habitat for water-dependent species such as beaver and muskrat (RETEC 2004, SWWRC et al. 2002).

In the Bighorn basin, the Loch Katrine, a playa lake enhanced and maintained by produced water from the Oregon Basin oil field in Park County, WY, is a nesting and feeding ground for many species of migratory birds, raptors and waterfowl, including two species of threatened and endangered species: peregrine falcon and bald eagle; and three candidate species: the long-billed curlew, white-faced ibis, and ferruginous hawk (Ramirez 1993). The Loch Katrine has received state and federal grants to maintain and improve the wetland complex. These funds help support local jobs and bird conservation programs.

Letters of beneficial use cite other instances of wildlife use of newly created and improved habitat in the Bighorn and Powder River basins (e.g., J. Wilson 1988, I. Schultz 1988, D. Grabbert 1988). Wild horse populations also frequent the Dry Creek area (G. Flitner, personal communication), and letters of beneficial use cite heavy dependence on the

discharges from the Oregon Basin oil field for maintaining wild horse herd sizes (FOAL 2006). Finally, in the Platte River basin, use attainability analyses identified 97 species of birds and mammals in the area near Poison Spider Creek that benefit from produced water discharges (Gene R. George & Associates et al. 2005).

The quality of produced water discharges in certain circumstances improves water quality of natural drainages. In drainages within the Powder River basin, natural background concentrations of TDS and sulfates can reach as much as 22,000 mg/L TDS and 12,000 mg/L sulfate, resulting in acute adverse effects in cattle and wildlife, including death (RETEC 2004, A. Baird 1988, J. Baird 1988). Ranchers in this area have indicated a preference for using produced water discharge, as concentrations from the effluent are lower than natural background concentrations in Salt Creek (RETEC 2004). In the Bighorn basin, increases in water flow in Dry Creek lessen the effects of evapoconcentration of natural waters, which can result in adverse effects on cattle (D. Schlaf; Appendix A).

2.3 W.S. 35-11-302(vi)(A) - The Character and Degree of Injury to or Interference with the Health and Well-Being of People, Animals, Wildlife, Aquatic Life and Plant Life Affected

The ERA (Chapter 1) found that there would be no incremental reduction in injury to the health and well-being of animals and wildlife if effluent limits were changed to the petitioners' requested limits. In addition, the social and economic injury to the people was evaluated as a result of changing the effluent limits.

The decision to change current effluent limits would affect not only water *quality*, but ultimately water *quantity*, because unnecessarily stringent effluent limits for produced water would likely result in reduced water discharge to surface water bodies. The economics of treating large quantities of produced water are such that injection/reinjection, deep disposal, and/or reduced exploration and development are likely results of additional treatment requirements.

2.3.1 Economic injuries of reduced exploration and development

Economically, field revenue from oil and gas extraction facilities provides jobs and associated earnings, production taxes and royalties, as well as basic export revenue. State-wide, the oil and gas industry supported 2,995 employees in 2002, with a total annual payroll of \$162 million (US Bureau of the Census 2002). In addition, support activities for oil and gas operations, including drilling of oil and gas wells, employed an additional 9,200 employees with earnings totaling \$332.6 million in 2002. The value of shipments, sales and receipts for oil and natural gas industries in Wyoming totaled \$3.9 billion (in 2002), representing ~14% of the total sales, shipments and receipts for the state. At least a portion of these revenues is expected to be negatively impacted by a loss of opportunity to surface discharge produced water.

For example, in the Bighorn basin, the Hamilton Dome oil field produces both oil and natural gas. Elimination of this oil field would result in a loss of \$28.7 million of total annual economic output (in 1997 dollars), and 136 jobs in Hot Springs County, with earnings totaling \$4.1 million annually (SWWRC et al. 2002). An additional 51 jobs across Wyoming are supported by this oil field.

In Natrona County, elimination of the South Casper Creek field, a crude oil production facility that surface-discharges produced water, would have resulted in the loss of over \$3 million of the county's basic exports in 2002, and losses of associated jobs, with annual earnings totaling \$487,142 in 2002 (Gene R. George & Associates et al. 2005).

Elimination of oil fields in the Salt Creek area of the Powder River basin would result in the loss of over 175 jobs and \$4.6 million in annual earnings (in 1997 dollars) for Natrona and Johnson counties (Taylor 1999).

2.3.2 Social injury of reduced oil and gas exploration/development

The presence and activity of oil and gas extraction facilities significantly contribute to the well-being of local communities, via fiscal contributions of taxes and royalties. County income from these operations supports various public facilities, including schools, hospitals, libraries, fire departments, environmental programs, and the county general fund.

In Natrona County, elimination of the South Casper Creek field would result in a reduction of property tax income by 2.5%, severance taxes by 0.04%, sales and use taxes by 0.16%, and 2.5% of federal royalties for the county (on average, between 1997 and 2002; Gene R George & Associates et al. 2005). The total dollar amount (in 2002 dollars) of the loss of these tax and royalty contributions is estimated at \$424,085.

Loss of funds associated with the Hamilton Dome oil field would reduce social contributions to Hot Springs County (in terms of fiscal contributions) totaling 29% of total property taxes, 9% of general fund revenues, 27% of the library system's total revenues, 2% of county hospital revenues, 9% of the county weed and pest management program, 29% of the rural fire district budget, and additional funds for school districts averaging \$1.4 million annually (SWWRC et al. 2002).

Elimination of the Salt Creek fields would result in losses of \$2.8 million in property tax revenue for Natrona County (in 1997 dollars): \$2 million for public schools, \$500,000 for county government, and \$300,000 for community colleges (Taylor 1999). State severance taxes for the Salt Creek fields in 1997 were estimated at \$2.4 million; 2.6% (\$62,257) of the

total severance tax was received by Natrona County and 0.2% (\$4,789) was received by Johnson County.

2.3.3 Economic injury of eliminating produced water discharges

Farming and ranching is a mainstay of many local economies across Wyoming. There were 5,282 cattle and calf ranches in Wyoming in 2002 (4,590 being beef cow ranches) and 5,191 irrigated cropland farms (NASS 2002). The total number of cattle inventoried in 2002 in counties¹ impacted by produced water discharges was 598,000 head. The combined marketing receipts from agricultural sales in Wyoming totaled \$864 million in 2002, with an average of ~\$91,700 per operation. Of the total, \$726 million was derived from livestock sales (~\$645 per head). Operators incurred \$518.5 million in production expenses, including livestock, feed, fuel, hired labor, and interest on loans. This leaves a residual net cash return of \$207.5 million, or an average of ~\$39,000 per livestock operation (before property taxes).

Drought conditions in an already semiarid climate with declining land availability and difficult market conditions have contributed to economic hardships for Wyoming farmers and ranchers in recent years. Rancher interviews in October and November 2006 cite drought-related herd reductions, between 10% and 30% or more (Appendix A). Others cite total dependence on produced water sources, as natural water bodies have disappeared (e.g., M. Brown 2006, L. Mantle 2002, D. Griebel 2002, J. Fike 2002, P. Renner 2002, M. May 2002, N. Sanford 2002, R. Larsen 2002, T. Brown and M. Brown 1988, D. Grabbert 1988). The number of cattle ranches across Wyoming declined 18% between 1997 and 2002. However, with the advent of produced water discharges, many ranchers and farmers are able to continue to make a living in Wyoming; in fact, cattle inventories have increased in recent decades, relative to national inventory numbers (Figure 2-1).

Data from the 2002 National Agricultural Statistics Service was gathered to evaluate economic indices in Wyoming and estimate losses from potential reductions in produced water outputs. In 2002, Wyoming farmers and ranchers reported an aggregate of 34.4 million acres of land in use as part of their operations. The total includes private, state and federal lands covered by grazing allotments, used as pastureland or grazing range. About

¹ Bighorn, Campbell, Converse, Fremont, Hot Springs, Johnson, Natrona, Sheridan, Washakie

1.54 million acres, mostly cropland, is irrigated. In the Cottonwood Creek area of the Powder River basin, 50% of irrigated land is pastureland, which provides winter and spring range and winter feed for the cattle and livestock herds (SWWRC et al. 2002).

Water loss from the Cottonwood Creek area would reportedly correspond to reductions in herd size, between 15% and 20%, resulting in an estimated loss of \$2 million in livestock sales, according to the use attainability analysis for Hot Springs County (SWWRC et al. 2002). Additional loss of irrigated pastureland was estimated at 8%. These pasturelands correspond to 1,600 acres of irrigated cropland and 4,000 tons of annual hay production. The use attainability analysis also estimates economic losses of 1.7% (\$3.3 million) of total annual economic output (in 1997 dollars) and \$645,000 in annual labor income associated with direct reduction in annual livestock receipts.

Ranchers (McCarty, Flitner, and Schlaf) in the Bighorn basin estimated reductions in herd sizes between 30% and 50% from loss of produced water in Dry Creek (Appendices A and B), resulting in an estimated loss of \$387,000 to \$645,000 in annual livestock sales (@ \$645 per head).

Herd reductions resulting from produced water losses in Salt Creek are estimated between 20% and 40% (RETEC 2004). This area supports more than 4,575 head of cattle (surveyed in 2002); corresponding losses of livestock sales from this area are estimated between \$590,175 and \$1.1 million (@ \$645 per head).

Letters of beneficial use from individuals indicate that reduced discharge to surface water bodies would result in herd reductions in many counties across Wyoming. The total number of cattle inventoried in 2002 in counties¹ impacted by produced water discharges was 598,000 head. Combined herd losses of 15% to 50% in these counties would incur estimated losses between \$57 million and \$192 million in livestock sales (@ \$645 per head).

Many ranchers cite additional costs of developing alternate water sources (wells, water hauling, ice breaking, etc.) if produced water were not available (e.g., M. Dennis 2006, D. Griebel 2003, N. Sanford 2002; G. Flitner and M. McCarty, personal communication; Appendix A). J. Kearns (1989) estimated an initial cost of \$140,000 and \$10,000 annually to

maintain watering wells on Bighorn basin properties if produced water were not available. Associated job losses are cited in several areas: at Cottonwood Creek, an estimated 20 full- or part-time jobs would be eliminated if there were no produced water discharge; and D. Flitner estimates that a portion of the 40 full- or part-time jobs in his Bighorn basin pastures are maintained by the use of grazing lands supported by produced water discharges (D. Flitner 2006). B. Basse, chairman of the Hot Springs County Commissioners, cites a heavy economic dependence on agriculture, tourism, and oil/gas industries, all of which would be negatively impacted by reduced water discharges in this area (SWWRC et al. 2002).

Finally, the economic impact of loss of wildlife populations would primarily affect revenue generated from hunting, fishing and tourism. In 2001, tourism accounted for an estimated \$1 billion in state revenue (Wyoming 2006). Sales from hunting and fishing licenses, travel, and lodging would be reduced as a result of loss of wildlife in many areas benefiting from produced water discharge. Revenues raised through license sales support state wildlife agencies, their conservation projects, and their hunter education and aquatic resources education programs. In addition, the Loch Katrine wetland complex receives governmental financial support for its maintenance and operation, which includes local jobs and bird conservation programs.

2.4 Summary and Conclusions

Wyoming DEQ must consider a range of criteria before recommending effluent limits (W.S. 35-11-302(vi)). These criteria include the character and degree of injury to the well-being of people, and the social and economic value of produced water discharge should be carefully weighed, because the decision to change current effluent limits would not only impact water *quality*, but also ultimately water *quantity*.

Numerous landowners in the Powder River and Bighorn basins of Wyoming benefit from produced water discharges, through irrigation and/or stock watering, with several examples highlighted above. Produced water also supports populations of wildlife species that may otherwise not be viable, including wild horse populations. In addition, produced water discharges in certain circumstances improve the water quality of natural drainages.

The risk assessment found that current WDEQ effluent limits pose no measureable adverse effect to the health and well-being of domestic livestock and wildlife. Furthermore, there would be no incremental reduction in wildlife or livestock injury if water quality effluent limits were changed to the petitioners' requested limits. The social and economic injury to people was evaluated as well.

Economic injuries of reduced exploration and development included lost revenue from oil and gas extraction facilities in the form of jobs and associated earnings, and basic export revenue:

- Elimination of the South Casper Creek field would result in losses of \$3 million (in 2002 dollars) to the basic exports of Natrona County, with additional losses of 18 jobs with annual earnings totaling \$487,142 (in 2002).
- Elimination of the Hamilton Dome oil field would result in losses of \$28.7 million (in 1997 dollars) in state total annual economic output, with associated losses of 136 jobs in Hot Springs County alone with earnings totaling \$4.1 million annually. An additional 51 jobs across the state of Wyoming are supported by this oil field.
- Elimination of the Salt Creek fields of the Powder River basin would result in the loss of over 175 jobs and \$4.6 million in annual earnings (in 1997 dollars) for Natrona and Johnson counties.

Social impacts include loss of financial contributions toward the improvement and well-being of local communities. County income from operations supported by produced water discharges include various public facilities including schools, hospitals, libraries, fire departments, environmental programs, and the county general fund:

- In Natrona County, elimination of the South Casper Creek field would result in reduction of related taxes and royalty contributions totaling \$424,085 (in 1997 dollars). These contributions account for 2.5% of county property tax income, 0.04% of severance taxes, 0.16% of sales and use taxes, and 2.5% of federal royalties for the county;
- Loss of funds associated with the Hamilton Dome oil field would reduce fiscal contributions to Hot Springs County totaling 29% of total property taxes, 9% of total general fund revenues, 27% of the library system's total revenues, 2% of county hospital revenues, 9% of the county weed and pest management program, 29% of the rural fire district budget, and additional funds for school districts averaging \$1.4 million annually (in 2002 dollars).
- Elimination of the Salt Creek fields in Natrona County would result in losses of \$2.8 million in property tax revenue (in 1997), of which \$2 million went to public schools, \$500,000 to county government, and another \$300,000 to community colleges. Additionally, state severance taxes for the Salt Creek fields in 1997 were estimated at \$2.4 million; 2.6% (\$62,257) of the total severance tax was received by Natrona County, and 0.2% (\$4,789) was received by Johnson County.

Even with continued industry presence, estimated costs of eliminating produced water discharges include:

- 15% to 20% loss of cattle in the Cottonwood Creek area, corresponding to an estimated \$2 million in lost livestock sales;
- economic losses of 1.7% (\$3.3 million) of total annual economic output and \$645,000 in annual labor income in Hot Springs County;
- an 8% loss of irrigated pastureland in the Cottonwood Creek area, corresponding to a loss of 1,600 acres of irrigated cropland and 4,000 tons of annual hay production;
- livestock losses estimated between 30% and 50% by several ranchers in the Bighorn basin, resulting in estimated losses of \$387,000 to \$645,000 in annual livestock sales;
- livestock losses estimated between 20% and 40% in the Salt Creek area, corresponding to an estimated \$590,175 to \$1.1 million in lost annual livestock sales;
- negative impacts state-wide from loss of livestock revenue;

- additional costs to ranchers to develop alternative water sources such as wells, water hauling and breaking ice;
- associated job losses related to ranching and farming;
- lost revenue from hunting, fishing and tourism due to declining wildlife populations; and
- lost access to federal funding and associated employment at the Loch Katrine wetland complex.

Loss of opportunity to surface discharge water would have a negative impact on oil and gas production, as well as jobs, across the state of Wyoming. State-wide, the oil and gas industry supported 2,995 employees in 2002, with a total annual payroll of \$162 million (US Bureau of the Census 2002). In addition, support activities for oil and gas operations, including drilling of oil and gas wells, employed an additional 9,200 employees with earnings totaling \$332.6 million in 2002. The value of shipments, sales and receipts for oil and natural gas industries in Wyoming totaled \$3.9 billion (in 2002), representing ~14% of the total sales, shipments and receipts for the state. At least a portion of this revenue is expected to be impacted by the loss of opportunity to surface discharge water. A state-wide analysis of economic and social benefits and injury from loss of produced water surface discharge, exploration and development is recommended to evaluate the total impact of the petitioners' proposed effluent limits.

3 References

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